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INTERPRETATION OF AIRBORNE MAGNETIC GRADIOMETER SURVEYS OF THE AREA SOUTH OF THE FLIN FLON-SNOW LAKE BELT (PARTS OF NTS 63K AND 63J)

By

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Winnipeg

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MAPS

N.T.S. Area	Total Field	Gradiometer	
63K/5 - N.E. quarter	C20346G	C40087G	in container
63K/6 - north half	C20342G	C40083G	in container
63K/7 - " "	C20340G	C40081G	in container
63K/8 - " "	C20351G	C40092G	in container
63K/9 - full sheet	C20352G	C40093G	in container
63K/10 - " "	C20341G	C40082G	in container
63K/11 - " "	C20343G	C40084G	in container
63K/12 - east half	C20347G	C40088G	in container
63J/5 - north half	C20349G	C40090G	in container
63J/12 - full sheet	C20350G	C40091G	in container

MAP 1

Airborne gradiometer interpretation south of the Flin Flon-Snow Lake area **in pocket**

Errata:

Maps referenced as "in container" are not included with report. These maps were released by the Geological Survey of Canada during the past few years. Copies, at $1.50 each, can be obtained from either:

Publications Office
Geological Survey of Canada
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Abstract

This report is an interpretation of the airborne magnetic gradiometer surveys flown in 1980, 1981 and 1982 over an area straddling the Precambrian-Paleozoic contact south of the Flin Flon-Snow Lake greenstone belt. It has been prepared to assist exploration and mining companies in their search for base metal and gold deposits.

A combination of airborne total field and vertical gradient data, together with geophysical data and drill logs from the assessment files, was used to develop a geological map of the Precambrian below the Paleozoic sediments.

The result of the interpretation revealed that the high-mineral-potential volcanics of the Flin Flon-Snow Lake belt extend southward below the Paleozoic limestones and dolomites.

INTRODUCTION

During 1980, 1981 and 1982 airborne magnetic gradiometer surveys were carried out in Manitoba over an area straddling the Precambrian-Paleozoic contact south of the Flin Flon-Snow Lake belt - see Figure 1. The surveys were carried out by the Geological Survey of Canada (G.S.C.) and were jointly funded by the Federal and Provincial Governments.

The main purposes of the survey were to delineate the Precambrian geology below the Paleozoic limestones and dolomites and to determine whether high-mineral-potential greenstone units of the Flin Flon-Snow Lake belt extend southward. The gradiometer has the ability to unravel areas of complex geology and because the overlying limestones and dolomites have extremely low magnetic susceptibilities this method was best suited for the project.

As the gradiometer method of surveying is a relatively new technique it was imperative to determine the magnetic gradient signatures produced by different lithologic units. To obtain this correlation the survey was extended north of the Precambrian-Paleozoic contact where the geology is well known. All the information, namely drilling, geophysical data, and geology from the assessment files for the Paleozoic area, was utilized. Coloured applicon total field and vertical gradient maps with interpreted geology are included with this report. A VLF-EM survey was carried out in conjunction with the gradiometer survey but is not included with this report as the data were of limited value in enhancing the geological interpretation.

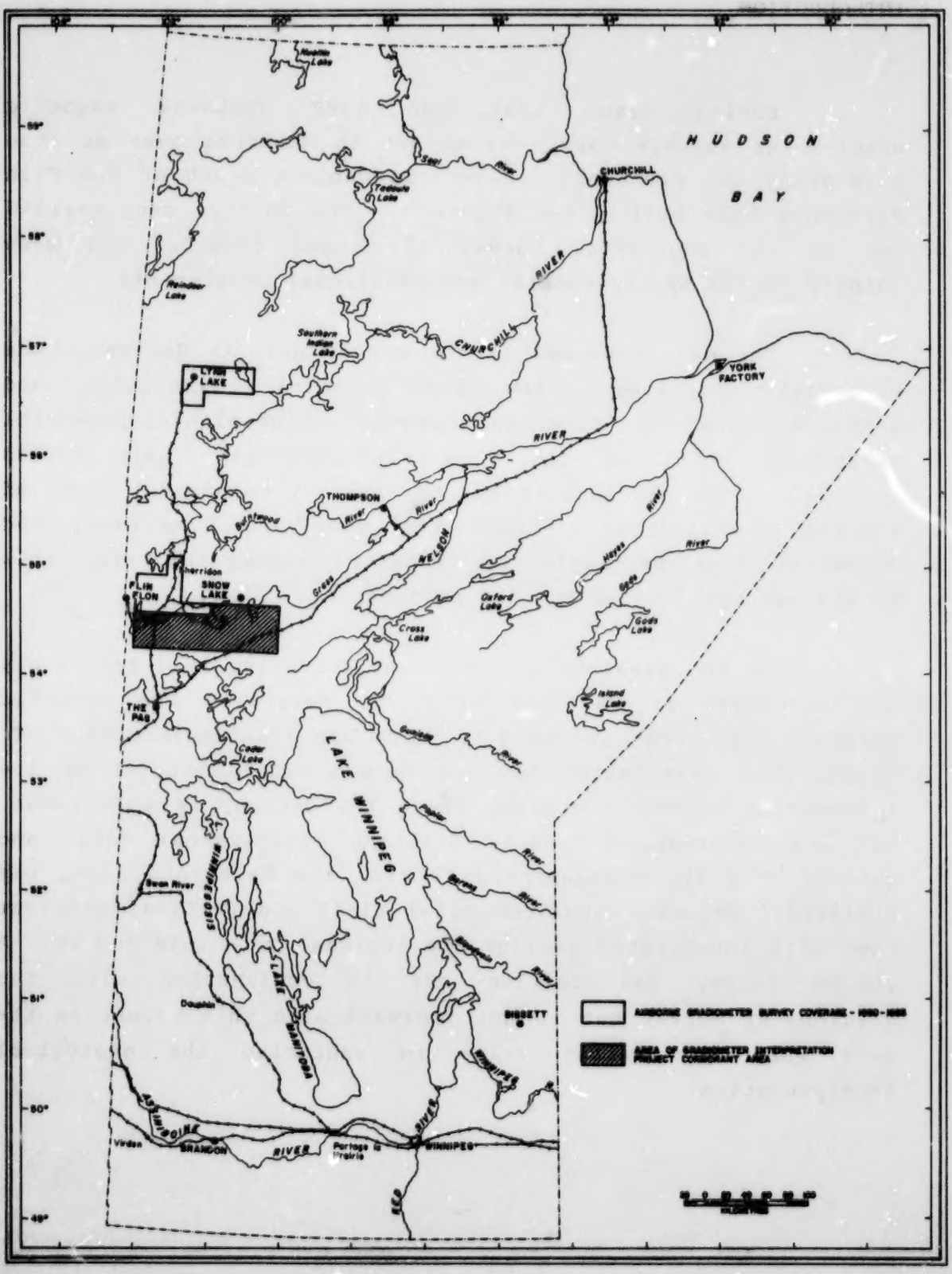

Figure 1: Airborne gradiometer survey coverage - 1980-1983

The results of the gradiometer survey reveal that the volcanic rocks extend southward below the Paleozoic sediments. Many faults and folds interpreted from the data could be important in outlining areas for base metal and gold exploration. Gneissic terrane characterized by moderate magnetic relief could host a Sherridon-type deposit. As many orebodies are located at or near the contacts of different lithologic units the ability to accurately locate contacts using the gradient data is of considerable value.

Approximately 6 months were spent in compiling data from over 200 assessment files. Approximately 300 drill logs were utilized. As most of the drilling was confidential the locations and mineralization encountered are not supplied with this report. As the southern part of the area is covered by Paleozoic sediments, the basement rocks do not outcrop. North of the Paleozoics the Precambrian area has been mapped by Bailes (1971).

ACKNOWLEDGEMENTS

The gradiometer program in Manitoba was made possible by the efforts of W.D. McRitchie of the Manitoba Mineral Resources Division, and A.G. Darnley and P.J. Hood of the Geological Survey of Canada.

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Close co-ordination was maintained between the Province and the Geological Survey of Canada during the analysis of the data. Special thanks are extended to L. Kornick of the Geological Survey of Canada for his suggestions in interpreting the data.

Thanks are also extended to B. Thakrar for typing the manuscript and to M. Carvalho for drafting the map.

HISTORY OF THE AIRBORNE VERTICAL GRADIOMETER

The vertical airborne gradiometer has been in limited use for at least 18 years. It was used mainly for hydrocarbon exploration. The sensors were installed in two towed birds having large separations, approximately 45 metres, that provided adequate sensitivity; the instrumentation available at that time was not capable of producing the low noise levels required for smaller separations. Because of the large sensor separations the gradiometer was used mainly for detecting deep sources which made it useful for hydrocarbon exploration. Noise due to air turbulence was a limiting factor on the ultimate performance that could be achieved. With the recent development of low noise high sensitivity magnetometers, a rigid system with a small sensor spacing has become possible.

In 1973 the Geological Survey of Canada commenced the fabrication of such a system and were the first to install it in an aircraft. The system reduced the turbulence-induced noise but as the sensors are coupled closely to the aircraft it required considerable compensation to counter the magnetic noise generated by the aircraft. As the system measures the difference in signals between the two sensors and the noise affects both sensors similarly, the drawbacks of having the measuring system close to the aircraft are compensated. The added advantage is the virtually constant sensor spacing, greatly improved vertical alignment and total freedom from swinging or rotation about the vertical axis (Lechow, 1983).

INSTRUMENTATION AND FLIGHT SPECIFICATIONS

The measuring system for the vertical gradient and total field data comprises two optical absorption magnetometers with a vertical separation of 2.05 metres, mounted on a rigid twin boom system on the tail end of a Queenair B-80 aircraft (see Fig. 2). The sensitivity of the magnetometers is of the order of 0.005 gammas. The aircraft is also equipped with a 35 mm camera and a VLF navigation system for flight path recovery. The altitude of the aircraft is determined by using a radar altimeter. The sampling interval is about 35 metres with a half second sampling rate. Data are recorded digitally on magnetic tape (Hood et al., 1979).

The altitude of the aircraft was kept at 150 metres and the flight line spacing at 300 metres. The western part of the survey area was flown along north-south flight lines whereas the eastern part was flown in an east-west direction. These orientations were selected to optimize alignment of flight lines as close to perpendicular as possible to the general strike of the lithologic units. This would maximize the amplitude and rate of change of the slope of the anomaly which would enhance its detectability. Also, depth, dip and width estimates of the causative body could be calculated more accurately.

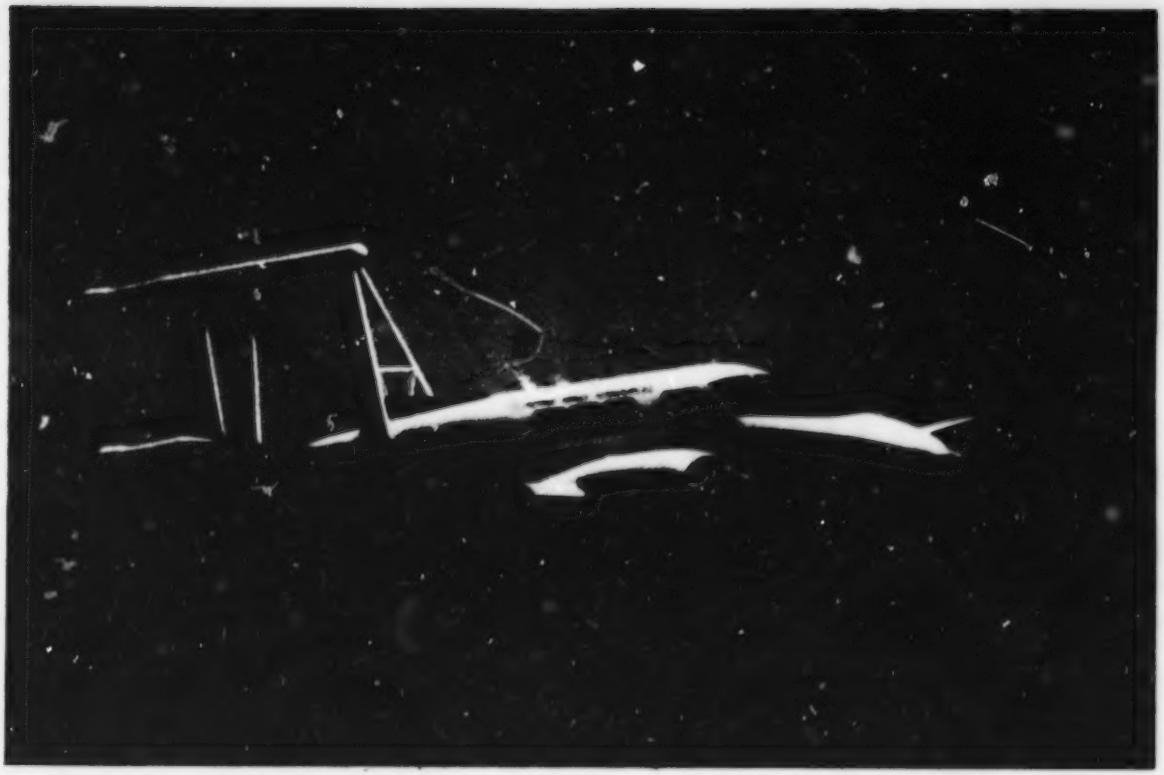

Figure 2. Airborne Gradiometer Survey Aircraft
(Courtesy Geological Survey of Canada)

ADVANTAGE OVER SINGLE SENSOR SURVEYS

The advantages of vertical gradient over single sensor total field magnetic surveys have been described by Hood (1976). They are as follows:

1. Superior resolution in delineating the lithologic contacts.
2. The zero gradient contour closely follows the lithologic contacts.
3. Anomalies produced by shallow bodies are emphasized compared to those originating from deeper buried bodies.
4. Diurnal variations and regional magnetic anomalies are automatically removed.

AREA COVERAGE

The area covered by the surveys extends from Goose Lake in the west to Hargrave Lake in the east. The National Topographic Series (NTS) maps covered were the northern half of 63K-5, 6, 7, 8 and 63J-5 and the sheets 63K-9, 10, 11, 12 and 63J-12. Future coverage will extend to the Manitoba-Saskatchewan border. The thickness of the Paleozoic sediments increases to approximately 70 metres at the southern end of the area.

GEOLOGY OF THE FLIN FLON-SNOW LAKE BELT

The Flin Flon-Snow Lake area is an important copper-zinc mining district and accordingly the area north of the Precambrian-Paleozoic contact has been mapped geologically in detail. The regional geological setting has been discussed by Bailes (1971) and is summarized as follows:

The Flin Flon-Snow Lake belt comprises four main sequences (from oldest to youngest): the Amisk Group; the post-Amisk Group; the Missi Group; and the post-Missi Group. The Amisk Group compises a thick sequence of volcanic strata ranging from basalt through rhyolite, with intercalated volcaniclastic sediments. These flow rocks are commonly pillowed and consist of mafic to intermediate pyroclastic rocks, which include agglomerate, tuff and ash deposits. The post-Amisk Intrusive Group includes quartz-eye granite and mafic intrusive rocks. The mafic intrusive rocks are of diverse origin and of different ages. Many of these intrusions contain ultramafic phases.

The Amisk Group and post-Amisk Intrusive Group are unconformably overlain by a relatively clean, detrital sequence of arkose, greywacke and quartzite forming the Missi Group. Pebble or boulder conglomerate beds are located at or near the base of the unit. Crossbedding is characteristic of the Missi rocks. The post-Missi Intrusive Group comprise large granite bodies, gneissic intrusive rocks of granodiorite composition and also acid to basic intrusive rocks which intrude the above granodiorite rocks.

Copper-zinc sulphide mineralization

The host rocks to the copper-zinc sulphide mineralization are acidic extrusives, intrusives, pyroclastics and tuffaceous volcanic rocks of the Amisk Group. The mineralization is commonly accompanied by chlorite and sericite alteration. Some orebodies are associated with metasedimentary rocks of the Amisk Group.

Gold mineralization

Gold occurs with the copper-zinc mineralization as well as separately. Gold-bearing quartz veins occur in shear or fracture zones in volcanic rocks commonly near the contact with large granite bodies, or in the marginal parts of the granite bodies themselves (J.F. Davies et al., 1962).

INTERPRETATION

The vertical gradient and total magnetic field maps accompanying this report were produced on an applicon plotter. The maps were made available by the G.S.C. on specified release dates (Weldon Bay-Goose Lake area - June 30, 1981; Iskwasum Lake area - October 27, 1982; McClarty Lake area - June 30, 1983). The vertical gradient values ranged from +7 to -10 gammas per metre. The total field values ranged from +2200 gammas to -650 gammas.

It is readily apparent that the gradient maps have a much better resolution than the total field maps. Within the felsic and mafic intrusions relief is recognized on the

gradient maps which is absent in the total field maps, indicating that the intrusions do not have a homogeneous susceptibility but are composed of higher and lower concentrations of mafic material. Delineation of the lithologic units is easier from the gradient maps making them invaluable for following mineralized horizons. Folds and faults are much more recognizable from the gradient than from the total field maps because of the truncation and offset of specific magnetic anomalies. On an apparent susceptibility map faults are indicated either by an abrupt change in susceptibility level or by a truncation of a linear trend. On the gradient map, faults are readily detected since individual anomalies are narrow (Letros et al., 1983).

A comparison was carried out by Hood et al. (1979) between the total field, the residual magnetic, the calculated vertical gradient and the measured vertical gradient maps of the White Lake survey. It was found that the boundaries of the granitic body and diabase dykes were discernible on all the maps. Secondary magnetic features caused by zones of higher concentration of mafic minerals within the granite were indicated on all but the total field map. However, only the two vertical gradient maps contained sufficient magnetic anomaly detail to delineate discontinuous trends of the compositional zoning within the granitic body. They also revealed discontinuities, termination and alignment of terminations of magnetic anomalies. These features are the magnetic expressions of faults within the granitic body. The measured vertical gradient map is the most useful for delineating the faults within the granite (Hood et al., 1979).

Gold has a tendency to remain at or near its source and since most of the gold comes from hydrothermal solutions, openings in the rocks caused by fracturing, shearing, faulting and shattering are essential structures for the accumulation of gold (Hood et al., 1982).

In carrying out the interpretation, the two types of maps have been used so that anomalies can be resolved into those produced by shallow sources or those extending to greater depths. The vertical gradient maps reflect the shorter wavelength and higher frequency content of the magnetic spectrum and therefore are biased towards the shallow sources, whereas the total field maps reflect combined shallow and deep-seated sources. In essence the gradient data are filtered total field data where the filter allows only the shorter wavelength and high frequency to pass through.

The vertical gradient is measured as the difference in total field values and can be compared to the first derivative (Irvine, 1982).

$$T = \frac{k}{h^n}$$

where T = total field value
k = geometric variable
h = distance from causative body
n = constant depending on shape of the causative body

The first derivative with respect to 'h' may be written as follows:

$$\frac{dT}{dh} = \frac{nk}{h^{(n+1)}}$$

Therefore an increase in 'h' will decrease the gradient more than the total field and hence the depth limitation of the gradient data. Generally the zero gradient contour delineates the contact of the different lithologic units which have sufficient magnetic susceptibility contrast to produce different gradient signatures.

Table 1 lists the range of susceptibilities for different rock types (Telford et al., 1977). The susceptibilities are in 10^{-6} c.g.s. units.

Table 1

Granite	0-4,000	Basalt	20-14,500	Limestone	2-280
Diorite	50-10,000	Rhyolite	20- 3,000	Peridotite	7,600-15,600
Gabbro	80-7,200	Dolomite	0-75	Andesite	13,500

From the table it is evident that the variation in susceptibility among the different rock types and also within the rock types themselves makes it difficult to identify a specific rock type on the basis of its magnetic signature alone. The extremely low susceptibilities of the dolomite and limestone are readily apparent. The degree of metamorphism and the type of environment (oxidizing or reducing) affect the magnetic susceptibility of the rocks. Examination of a profile in Clarendon Township, Ontario, indicated several discrepancies between mapped lithological composition and observed magnetic susceptibility. These were thought to be the result of metamorphic influence on the magnetic constituents within these rocks leading to increased oxidation states. A metamorphosed gabbro had apparently undergone sufficient alteration to

significantly decrease its magnetic susceptibility, presumably by oxidation (Lechow, 1983).

The G.S.C.'s vertical gradiometer system was designed to map near-vertical contacts between rock formations having a minimum effective susceptibility contrast of about 50 x 10^{-6} nH. cm^{-3} (Hood et al., 1979).

The area under investigation is large in extent (approximately 150 x 30 kilometres) and therefore has been divided into magnetic "Domains" according to the general gradient and total field signatures. This approach was used as the geology is interpreted from the magnetics and therefore the general magnetic background is considered in separating the different "Domains" (see Map 1).

Domain A

Domain A is herein defined as the area north of the northeast-trending high magnetic zone (Domain B). Towards the western part of Domain A the gradient is comparatively featureless. This area consists of relatively non-magnetic Missi conglomerate and greywacke. East of the Missi, the area is underlain by Amisk acid and basic volcanics which contain some gabbroic intrusions having a higher magnetic signature than the surrounding volcanics. This domain is situated north of the Paleozoic-Precambrian contact and is therefore geologically mapped in detail.

Domain B

Domain B comprises the high magnetic total field northeast-trending zone. This zone is approximately 10 kilometres wide and has a minimum length of 50 kilometres. This zone is resolved into bands of positive and negative anomalies on the gradient map which indicates banding of high and low magnetic units. The continuity of these units is interrupted by a circular intrusion north of Goose Lake. The intrusion comprises negative magnetic gradients in the centre with high positive gradients along the rim. Drilling indicates that this intrusion consists of a granodiorite core with a gabbroic rim. Drilling carried out over some of the northeast-trending high magnetic units intersected andesite and basalts whereas the drill holes close to the contact of the high and low magnetic units intersected dacite and mafic volcanics. One hole drilled in the area of magnetic lows intersected acid volcanics whereas another hole intersected sericite schist. The continuity of these units is delineated from the gradient maps. A few northwest-trending faults interpreted by the truncation of the gradient anomalies offset the continuity of these units. Towards the northern boundary of this Domain are three ellipsoidal areas of relatively flat gradients which could be caused by granodiorite intrusions. The extremely high magnetic gradient defining the southern margin of Domain B is caused by iron formation, confirmed by drilling carried out by the Geological Services Branch (McCabe, 1982).

Domain C

South of the high magnetic zone is an area composed of granite and biotite gneiss which is referred to as Domain C. Many holes drilled by mining companies and one hole drilled by the Geological Services Branch (McCabe, 1983) confirmed the rock types. Within the gneiss are long narrow bands with high magnetic gradients and coincident strong electromagnetic (EM) conductors. Drilling the conductors indicated wide intersections of barren massive sulphides (pyrrhotite and pyrite). Scattered northwest-trending faults, interpreted from the gradient maps, offset some of the zones of massive sulphides.

Towards the central area of Domain C a northwest-trending fault offsets the boundary between Domains B and C resulting in the gneissic terrane extending in a northward direction towards the east. In this area within the gneissic terrane are long narrow bands of high magnetic gradients which could possibly be caused by sulphides. According to the assessment files no drilling has been carried out in this area.

In the central area of Domain C is a zone of high and low magnetic gradients. The high gradients, which are circular in shape, could be caused by gabbroic intrusions, whereas the elongated gradient anomalies could be caused by massive sulphides in gneisses. These interpretations have been confirmed by drill hole information on four of the anomalies.

Domain D

Most of the area that Domain D encompasses is situated north of the Paleozoic-Precambrian contact and therefore has been geologically mapped. This Domain extends approximately 15 kilometres in the east-west direction and extends approximately 5 kilometres south from the Paleozoic-Precambrian boundary. According to geological mapping and drill hole data the area consists mostly of hornblende-biotite gneiss with three ellipsoidal granodiorite intrusions in the area north of the Paleozoic-Precambrian boundary. The western and central ganodioritic intrusions have a relatively flat gradient signature with a rim of relatively higher magnetics which could be caused by a concentration of hornblende and biotite. According to the gradient map the hornblende-biotite gneiss extends to the southern boundary of Domain D. According to geological mapping and drill hole information the area between the central granodiorite intrusion and the eastern boundary is composed of acid and basic volcanics. The magnetic gradient signatures of these volcanics are similar to the hornblende-biotite gneiss, implying a similar overall susceptibility.

Towards the east of this Domain and in the area of Paleozoics are two semi-circular gradient signatures one of which is relatively flat magnetically whereas the other has strong magnetics. Drilling indicates that the strong signature is caused by a gabbroic intrusion whereas the relatively flat magnetic response of the other intrusion is interpreted as being caused by granodiorite.

Domain E

Domain E is situated south of Domain D and extends approximately 50 kilometres in the east-west direction at the southern boundary of the survey. It is entirely within the Paleozoic area. The overall magnetic signature is relatively flat. The area can be interpreted as being composed of granite and biotite gneiss from the overall magnetic signatures. One hole drilled by the Geological Services Branch confirmed this rock type (McCabe, 1983).

In the northwestern part of this domain long narrow magnetic anomalies are folded on a regional scale. These anomalies are similar to those in Domain C, caused by massive sulphides, and therefore warrant further investigation.

Domain F

Domain F covers an area of approximately 20 kilometres in an east-west direction and extends from the northern boundary of the survey to approximately 15 kilometres south from the Paleozoic-Precambrian boundary. This domain encompasses Iskwasum Lake and the western part of Reed Lake.

North of the Paleozoic-Precambrian boundary the area has been mapped geologically. A circular granodiorite towards the western part of this domain has a relatively flat gradient signature. The granodiorite is surrounded by serpentinite and gabbroic rocks which produce strong magnetic anomalies. East of the strong magnetic anomalies is an area of relatively flat magnetics which are mapped as granodiorites. East of the granodiorites are strong north-trending magnetic anomalies that

are caused by serpentinites and gabbros. Drilling in the Reed Lake area intersected acid and basic volcanics which extend to the eastern boundary of this domain. The gradient signatures of these volcanics are magnetically stronger than those produced by the granodiorites but are not as as strong as those produced by the serpentinites and gabbros. Similar signatures are recorded in the area south of the Precambrian-Paleozoic boundary which could be interpreted as volcanics having similar susceptibilities. Some drill holes in the Paleozoic area intersected acid and basic volcanics. Within the volcanics are two semi-circular high magnetic anomalies which can be interpreted as being caused by gabbroic intrusions. The large intrusion with a diameter of approximately 6 kilometres has been drilled and gabbro was intersected. The presence of volcanics south of the Paleozoic-Precambrian boundary would make it a favourable area for exploration.

From the gradient map the general trend of the anomalies produced by the volcanics is in a north-easterly direction. In places their continuity is truncated by possible northwesterly-trending faults. Only in the area of the Paleozoic-Precambrian contact do the volcanics trend east-west. This change in orientation of the volcanics may be caused by an east-west fault interpreted across the length of this domain.

Domain G

Domain G encompasses a large area extending from approximately the centre of Reed Lake eastward to Wekusko Lake, a distance of approximately 40 kilometres. Its northern and southern limits fall outside the boundaries of the surveyed

area. The western limit of Domain G corresponds with the eastern boundary of Domain F whereas the eastern boundary abuts the western boundary of Domain H.

Most of the area of Domain G comprises acid and basic volcanics with sediments. This area is highly disturbed with many northwest-, northeast- and sporadic north-trending faults. It contains several mineral deposits - Reed Lake, Spruce Point, Copper-Man, Sylvia Zone and Farewell Lake.

Mapping and drill hole information north of the Paleozoic-Precambrian boundary indicates the presence of volcanics, granodiorite, granite gneiss and gabbroic intrusions. In the northern part of Reed Lake the north-trending gradient anomalies are caused by basic volcanics and a circular gabbroic intrusion (Jackfish Lake) confirmed by drill hole data. In the central and southern part of Reed Lake drilling indicates acid and basic volcanics. The gradient anomalies produced by the volcanics are not as strong as those produced by the gabbros. The general gradient signatures towards the northeast of Reed Lake are of less magnitude than those produced by the volcanics. Drilling intersected granite and biotite gneiss in the area.

Within the Paleozoic area south of the Spruce Point deposit a large (9 x 9 kilometres) gabbroic and diorite intrusion is interpreted from the gradient map and confirmed by drilling (assessment files and Geological Service Branch - McCabe, 1983). The northeast and southwest boundaries interpreted from the gradient map are sharp and linear and therefore appear to be truncated by northwest-trending faults. The Spruce Point deposit is situated close to one of the faults. The total magnetic fields surrounding the intrusion

are very low. Drilling indicates acid and basic volcanics with some sediments. A hole drilled just west of the gabbroic intrusion intersected metagreywacke (McCabe, 1983).

Immediately east of Farewell Lake the total field and gradiometer map portays a large (11 x 6 kilometres) ellipsoidal intrusion of strong magnetic signature which drilling has confirmed to be caused by gabbro and diorite. On the total field map the intrusion seems to have a homogeneous susceptibility but from the gradient it seems to have high and low magnetic signatures, indicating some layering of high and low susceptibility units. Drilling and the gradient map indicate that the area surrounding the intrusion comprises acid and bacic volcanic rocks with some sediments. The Sylvia Zone and the Farewell Lake deposits are situated within these volcanics south and east of the intrusion. Northwesterly-trending faults in the area are interpreted from the gradient map. Another gabbroic intrusion (1 x 5 kilometres) is interpreted from the total field and gradient map, based on its high magnetic values; it is located at the southern extremity of the survey area.

In the southeastern area of Domain G the total field and gradient maps outline an ellipsoidal high magnetic anomaly approximately 5 by 2 kilometres in area. Drilling proved that this anomaly is caused by a gabbroic intrusion. Surrounding this intrusion the total field values are extremely low whereas the gradient values north of the intrusion are without any relief. A few drill holes on the periphery of this low magnetic area intersected sediments. Immediately north of the low magnetic area the gradient map outlines approximately north-trending anomalies which have the magnitude of volcanics and sediments which drilling has confirmed. The Copper-Man

deposit is situated within these volcanics. The linear gradient anomalies produced by the volcanics and sediments are truncated in places which would indicate possible northwesterly-trending faults. Immediately west of the Copper-Man deposit a circular magnetic low is outlined on the total field and gradient map. One hole was drilled by the Geological Services Branch (McCabe, 1983) to investigate this magnetic low; gabbro was intersected. It was stated earlier that the environment may have an effect on the susceptibility; this is a case in point, as the gabbro has undergone sufficient alteration to decrease its magnetic susceptibility.

Domain H

Domain H encompasses the Hargrave Lake area and stretches from Domain G on the west to the eastern boundary of the survey area, a distance of approximately 18 kilometres. The northern and southern limits extend to the boundaries of the survey area. In this area the Paleozoic-Precambrian contact swings towards the northeast; as a result, most of this Domain falls within the Paleozoic area.

The total field map shows the area to have relatively featureless magnetic signatures but the gradient map outlines northeast-trending gradient anomalies having a magnitude in the range of either mafic gneiss or volcanics. Drilling in the area intersected biotite-hornblende gneiss in the high magnetic areas and granite gneiss in the area where the gradient values are low. Deep penetrating EM surveys are recommended to determine whether the mafic bands are electrical conductors. Scattered northwesterly faults offset the continuity of some of these bands. Two holes drilled by the Geological Services

Branch (McCabe, 1983) intersected hornblende- and biotite-bearing tonalite and granite and biotite-bearing quartz diorite.

CONCLUSIONS

The results of the airborne gradiometer survey together with the drilling data have been useful in interpreting the geology below the Paleozoic sediments south of the Flin Flon-Snow Lake greenstone belt. It is an excellent tool for delineating the extensions of lithologic units where there is some drill hole control. As the range of susceptibilities of some of the rock types overlap, drill hole information is important in their identification. The susceptibility contrast between some rocks, for example a granite and a gabbro, is so great that they can be recognized by their magnetic signatures, as well as by their generally circular or ellipsoidal shape. Faults can be interpreted from truncation and offset of magnetic trends and folding is recognized by flexures in magnetic trends. As with any geophysical method any one technique on its own cannot be completely accurate in interpreting the geology.

The interpretation of the total magnetic field and vertical gradient data has proved that the high mineral potential greenstone units extend southward beyond the Paleozoic-Precambrian boundary over an east-west distance of approximately 90 kilometres. Much of the remaining area (60 kilometres) comprises gneissic terrane which portrays some relief on the gradient map. This may be important in exploring for a Sherridon-type deposit.

FUTURE PLANS

Under the Canada-Manitoba Mineral Development Agreement the gradiometer coverage will be extended south and west of the present area. The results should be useful to companies carrying out exploration in the area.

A "scout" drilling program combined with surface and borehole magnetic susceptibility measurements is being undertaken by the Provincial and Federal Governments as part of the activities scheduled under the Mineral Development Agreement. As the data become available they will be incorporated into the present interpretation and the report and map will be updated.

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101°45'00"
54°40'00"

GABBRO

ACID AND BASIC VOLCANICS

GRANODIORITE GNEISS

GREYWACKE

ARGILLITE

GABBRO DIORITE

DOMAIN "A"

ANDESITE

ARGILLITE ANDESITE

DACITE ANDESITE

GRAPHITE-SCHIST

GRANODIORITE GNEISS

GRANODIORITE GNEISS

DIORITE

ANDESITE, RHYOLITE, ARGILLITE

ARGILLITE-DACITE

RHYOLITE

HORNBLENDE BIOTITE GNEISS

GR

AND

STIC VOLCANICS

DOMAIN "B"

ANDESITE ARGILLITE

SER. SCHIST

DIORITE

GRANODIORITE

GNEISS

GRANODIORITE

EISS

Manitoba
Energy and Mines

100°15'00"
54°45'00"

100°15'00"
54°45'00"

BIOTITE GNEISS

GRANODIORITE

HORNBLENDE GRANODIORITE
HORNBLENDE BIOTITE GNEISS

BIOTITE GNEISS

GABBRO
DIORITE

BASIC VOLCANICS

HORNBLENDE GNEISS

REED LAKE

ACID AND BASIC VOLCANICS

RHYOLITE, ANDESITE

BIOTITE GNEISS

ARGILLITE

GRANITE AND BIOTITE

ARGILLITE, GREYWACKE

ZOPPING LAKE

PRECAMBRIAN PALEOZOIC BOUNDARY

ACID AND BASIC VOLCANICS AND METASEDIMENTS

GRANITE GNEISS

ACID AND BASIC VOLCANICS AND SEDIMENTS

95°30'00"
54°45'00"

ARGILLITE, GREYWACKE

GRANITE GNEISS

GRANITE AND BIOTITE GNEISS

GRANITE AND BIOTITE GNEISS

DOMAIN "H"

PRECAMBRIAN / PALEOZOIC BOUNDARY

ACID AND BASIC VOLCANICS AND SEDIMENTS

GABBRO

GRANITE

GRANITE GNEISS

GRANITE AND BIOTITE GNEISS

DOMAIN "A"

GREYWACKE

ARGILLITE

GABBRO DIORITE

ANDESITE

ARGILLITE

DACITE ANDESITE

GRAPHITE-SCHIST

GRANODIORITE GNEISS

ATHAPARUSKOW LAKE

PRECAMBRIAN PALEOZOIC BOUNDARY

CHL. SCHIST

GRANODIORITE

CHL. SCHIST

ANDESITE

GOOSE LAKE

GRANODIORITE GNEISS

SIC VOLCANICS

DOMAIN "B"

DIORITE

GRANODIORITE GNEISS

IRON FORMATION

GRANODIORITE

GNEISS

HORNBLENDE BIOTITE

ANDESITE ARGILLITE

LAKE

POSSIBLE BANDS OF

GRANITE AND

DOMAIN "C"

GRANITE GNEISS

SIMONHOUSE

GRANODIORITE GNEISS

ACID AND BASIC VOLCANICS

SERPENTINE-GABBRO

GREYWACKE

GRANODIORITE GNEISS

GRANODIORITE GNEISS

ACID AND BASIC VOLCANICS

GABBRO

GABBRO

GABBRO

HORNBLENDE BIOTITE GNEISS

GRANODIORITE GNEISS

HORNBLENDE BIOTITE GNEISS

GRANODIORITE GNEISS

DOMAIN "D"

GRANODIORITE GNEISS

ACID AND BASIC VOLCANICS

GABBRO

GRANODIORITE GNEISS

PROBABLE ACID AND BASIC VOLCANICS

DIORITE-GABBRO

GABBRO

GABBRO

LAKE

GABBRO

GABBRO

BIO. GNEISS

BIO. GNEISS WITH POSSIBLE MAS. SULPHIDES

ACID AND BASIC VOLCANICS

GABBRO

GABBRO

DOMAIN "F"

GABBRO

BIO. GNEISS

DOMAIN "E"

GRANITE AND BIOTITE GNEISS

REED LAKE

RHYOLITE, ANDESITE

BIOTITE GNEISS

ACID AND BASIC VOLCANICS AND SEDIMENTS

PRECAMBRIAN / PALEOZOIC BOUNDARY

ARGILLITE

GRANITE GNEISS

ACID AND BASIC VOLCANICS AND METASEDIMENTS

GRANITE AND BIOTITE GNEISS

IRON FORMATION

FAREWELL LAKE

GABBRO

DIORITE

ANDESITE DIORITE DACITE

GABBRO-DIORITE

ANDESITE BASALT

ANDESITE, RHYOLITE

ANDESITE RHYODACITE META. SEDS

META. SEDS

SEDIMENTS

GREYWACKE

ANDESITE - ARGILLITE

CHL. BIO. SCHIST

ANDESITE RHYODACITE TUFF

MAFIC VOL. & ARGILLITE

ANDESITE FELSIC VOLC.

ANDESITE

GRANITE

DIORITE META SEDS

BIO. GNEISS

BIO. SCHIST ANDESITE, RHYODACITE

RHYOLITE DACITE

META. SEDS. MASSIVE SULPHIDES

META. SEDIMENT SCHIST

ACID AND BASIC VOLCANICS AND METASEDIMENTS

MCCLARTY LAKE

DOMAIN

RHYOLITE

ACID AND BASIC VOLCANICS AND SEDIMENTS

ANDESITE DACITE

AMPHIBOLE

BIOTITE

PRECAMBRIAN / PALEOZOIC BOUNDARY

DOMAIN "H"

ACID AND BASIC VOLCANICS AND SEDIMENTS

VOLCANICS
DIMENTS

GABBRO

GRANITE GNEISS

GRANITE AND BIOTITE GNEISS

ANDESITE RHYODACITE META. SEDS.

META. SEDS.

GABBRO

GRANITE

ANDESITE RHYOLITE

ANDESITE RHYOLITE

SEDIMENTS ANDESITE

SEDIMENTS

PERIDOTITE

GNEISS

DIORITE

GREYWACKE

ANDESITE

RHYODACITE

ANDESITE DACITE

SEDIMENTS

GABBRO

AMPHIBOLE GNEISS AND BIOTITE GNEISS

GRANITE AND BIOTITE GNEISS

HARGRAVE LAKE

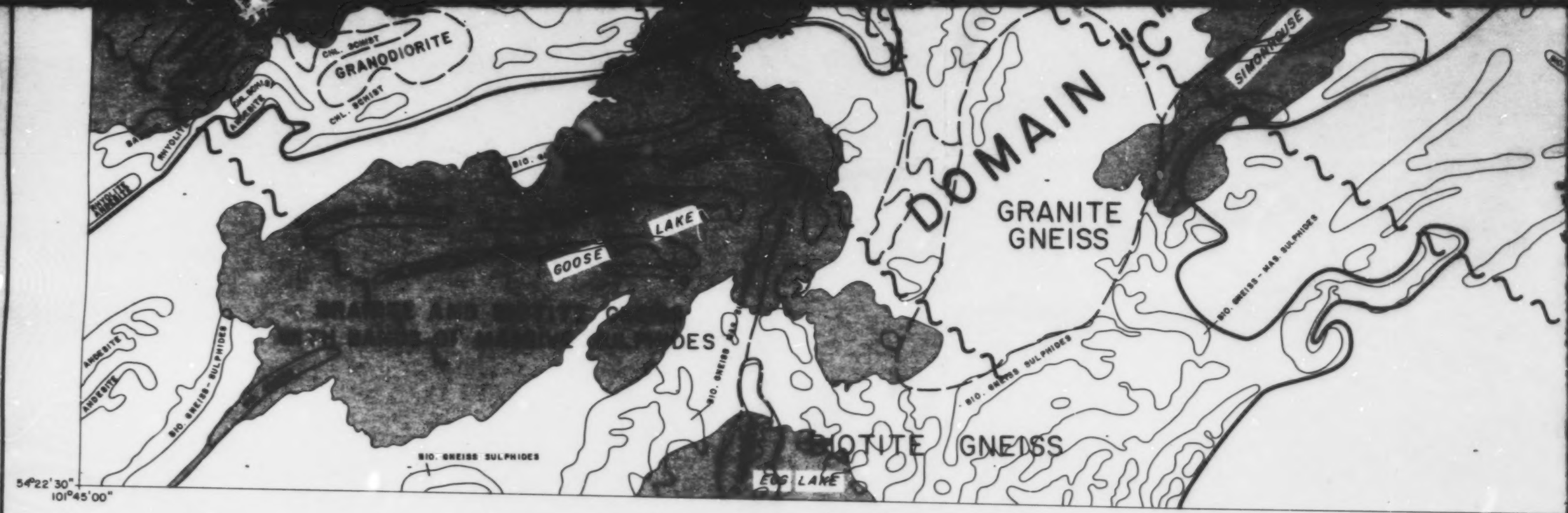
RHYOLITE

RHYOLITE, DACITE

BIO. GNEISS Py, Po

BIO. GNEISS

BIO. GNEISS Py



LEGEND

LITHOLOGIC UNITS

GRADIOMETER SIGNATURES

PRECAMBRIAN–PALEOZOIC BOUNDARY

FAULTS

DOMAINS

LAKES

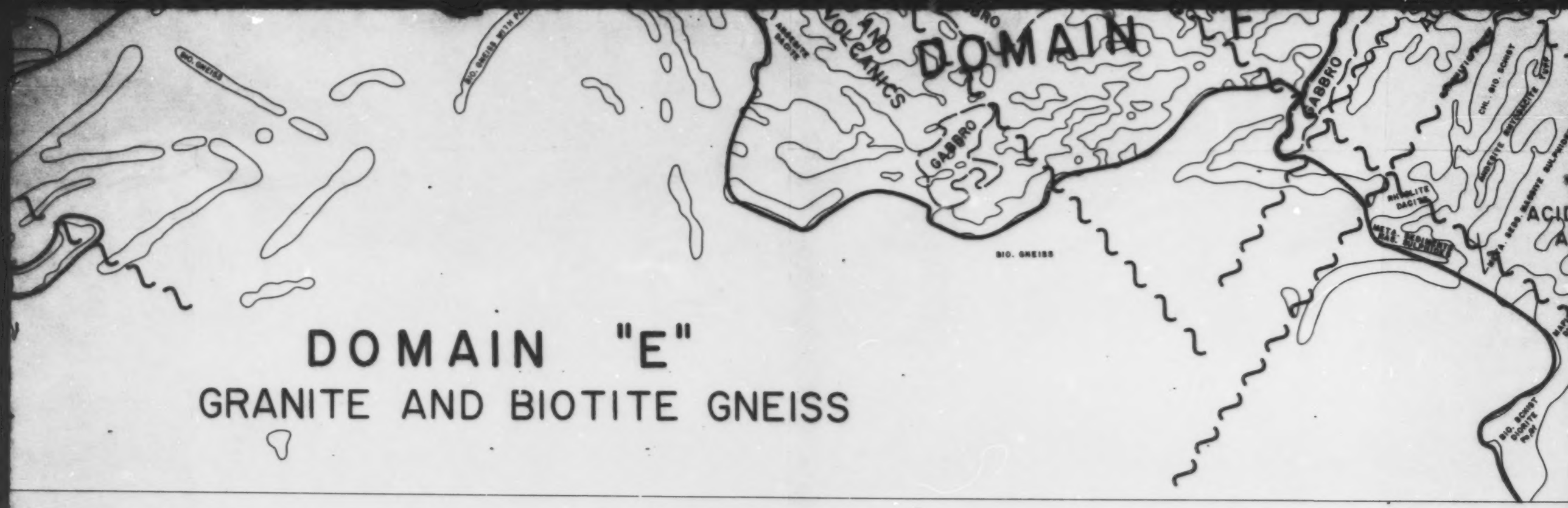
▲1 REED LAKE DEPOSIT

▲2 SPRUCE POINT MINE

▲3 COPPER–MAN DEPOSIT

▲4 SYLVIA ZONE DEPOSIT

▲5 FAREWELL LAKE DEPOSIT



DOMAIN "E"

GRANITE AND BIOTITE GNEISS

POSIT

MINE

EPOSIT

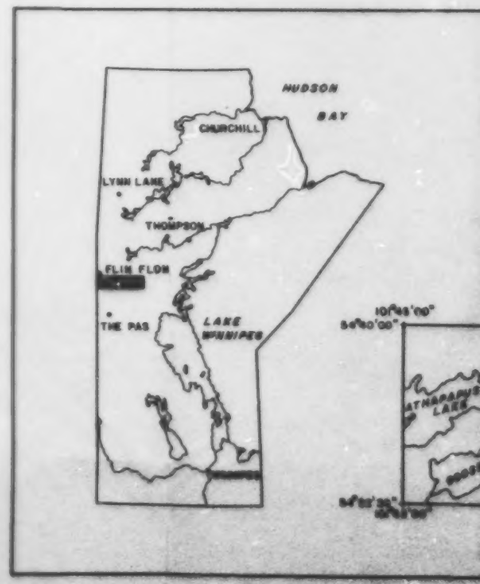
DEPOSIT

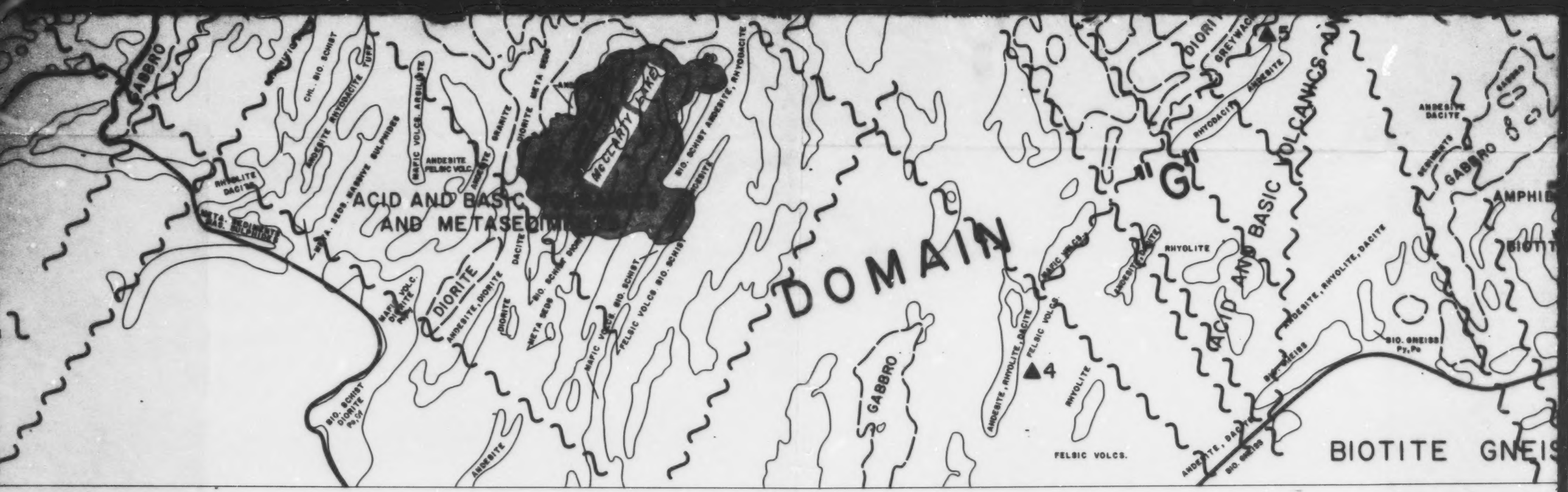
DEPOSIT

INTERPRETATION BY: I T HOSAIN
CARTOGRAPHY BY: MANUEL CARVALHO

Scale 1:100 000

KILOMETRES 2 0 2 4 6 8 10 KILOMETRES





INDEX MAP

Scale 1:1 000 000

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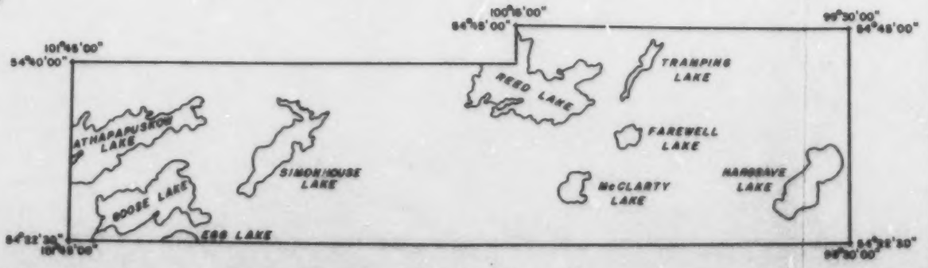
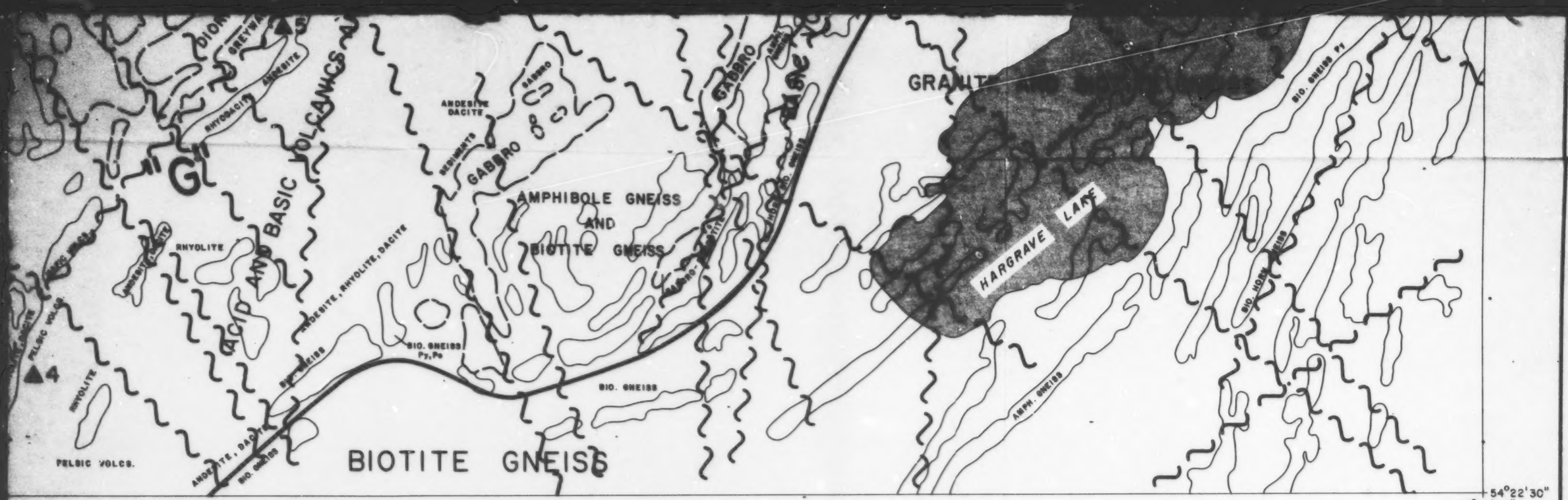


AIRBORNE
SOUTH OF T



MAP OF84-2

AIRBORNE GRADIOMETER INTERPRETATION SOUTH OF THE FLIN FLON - SNOW LAKE AREA

POOR

QUALITY

ORIGINAL